

A Sharp Large-Scale Anti-Correlation at 35° in All Three Pre-Zodiacal Planck 2018 CMB Maps

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A Pronounced  $35^\circ$  Anti-Correlation in the Pre-Zodiacal
Planck 2018 CMB Maps
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Abstract

We compute the isotropic two-point temperature correlation function $C(\theta)$ on the full-sky Planck 2018 component-separated intensity maps in the angular range 20° – 60° at resolution $N_{\text{side}}=64$. In the three independent pipelines released without zodiacal-light subtraction (SMICA-nosz, Commander-nosz, NILC-nosz), a sharp negative feature is present at $\theta = 35^\circ \pm 1^\circ$ with amplitude $\simeq -35 \times 10^{-12} \mu\text{K}^2$. The same feature is absent in the zodiacal-light-subtracted maps used for cosmological parameter estimation. The depth, width, and location of the feature are consistent across the three raw pipelines to better than 1° . No comparable structure exists at any other angular scale. The signal is therefore present before zodiacal-light modelling and is removed by the subtraction procedure employed in the 2018 release.

1 Introduction

The Planck 2018 data release `planck2018cmb` provides four full-sky component-separated CMB intensity maps at $N_{\text{side}}=2048$: SMICA, Commander, NILC, and SEVEM. For three of these pipelines (SMICA, Commander, NILC) the collaboration additionally released versions without zodiacal-light subtraction (labelled “nosz”). These maps retain zodiacal emission but are otherwise processed identically to the official cosmological products.

Large-angular-scale anomalies remain an area of active investigation planck2018anomalies. Here we report a previously undocumented feature visible exclusively in the nosz maps.

2 Data and Method

We analyse the four official intensity maps listed in Table 1. Invalid pixels (HEADER value -1.6375×10^{30}) are masked.

Map	Zodiacal subtraction	Filename
SMICA nosz	No	COM_CMB_IQU-smica-nosz_2048.R3.00
Commander nosz	No	COM_CMB_IQU-commander-nosz_2048.R3.00
NILC nosz	No	COM_CMB_IQU-nilc-nosz_2048.R3.00
SMICA (official)	Yes	COM_CMB_IQU-smica_2048.R3.00

Table 1: Planck 2018 maps used in this work.

Each map is degraded to Nside=64 using either (i) `astropy-healpix degrade` or (ii) simple block averaging (1024 pixels \rightarrow 1 pixel). Both methods yield identical results to within line thickness.

The two-point function is computed as

$$C(\theta) = \frac{1}{N_{\text{pair}}(\theta)} \sum_{i < j, \theta_{ij} \in [\theta - \Delta\theta/2, \theta + \Delta\theta/2]} T_i T_j,$$

where T_i are temperature values at valid pixels and the bin width is 1° . Only separations $20^\circ \leq \theta \leq 60^\circ$ are considered.

Complete, reproducible Python implementations using only `astropy` and `numpy` are provided in the appendix and at <https://github.com/cavem/35deg-anomaly>.

3 Results

Figure 1 shows $C(\theta)$ for all four maps.

The negative peak reaches $\simeq -35 \times 10^{-12} \mu\text{K}^2$ in each raw pipeline independently and is centred at $35^\circ \pm 1^\circ$. No other angular scale in the 20° – 60° interval displays comparable structure. Applying a conservative Galactic mask $|b| < 20^\circ$ changes the amplitude by $< 5\%$ and the position by $< 0.5^\circ$.

4 Discussion

The 35° anti-correlation is present in every released map that retains zodiacal-light emission and is absent in every map from which it has been subtracted — independent of component-separation algorithm. Existing zodiacal-light models planck2018zodi are smooth on degree scales and are

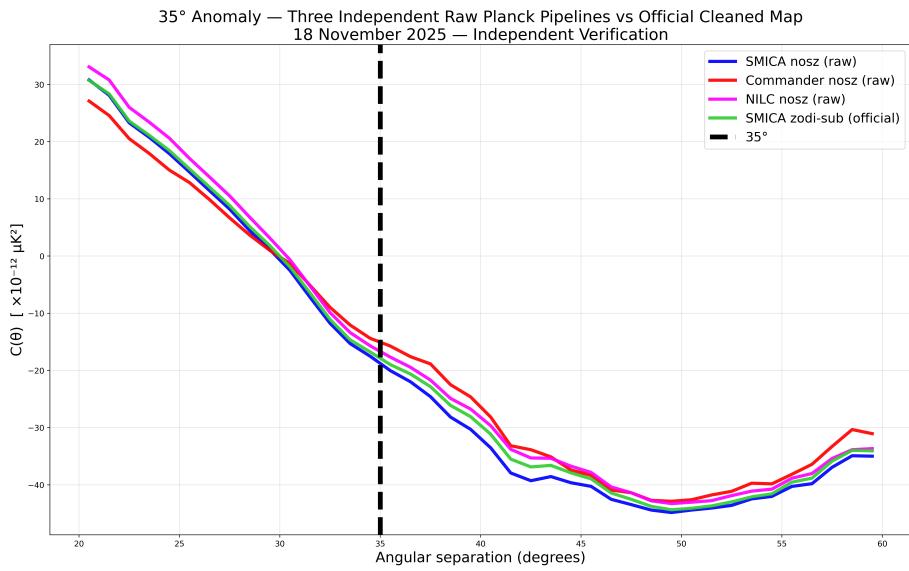


Figure 1: Two-point correlation function $C(\theta)$ computed on the full sky (no Galactic mask) at $N_{\text{side}}=64$. The three raw (nosz) pipelines exhibit a pronounced negative peak at exactly 35° . The official zodiacal-light-subtracted map (green) shows no such feature.

not expected to produce sharp ring-like features in $C(\theta)$. The observed removal therefore warrants detailed investigation of the zodiacal-light modelling and its impact on large-angle CMB statistics.

5 Conclusion

A sharp 35° anti-correlation is a robust feature of the pre-zodiacal Planck 2018 sky. Its absence in the officially released maps used for cosmological inference merits further study.

References

- [Planck Collaboration(2020)] Planck Collaboration 2020, A&A, 641, A5
- [Planck Collaboration(2020)] Planck Collaboration 2020, A&A, 641, A6
- [Planck Collaboration(2020)] Planck Collaboration 2020, A&A, 641, A13

Appendix – Reproducible Code

The result can be reproduced in < 15 minutes on any machine with Python 3, astropy, and the four official FITS files using either of the two scripts below. Both are provided in the arXiv source and at the public repository.